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Safety, Health and Environmental Management Strategies Implemented to Safeguard Unki Platinum Mine's Host Communities in Shurugwi District, Zimbabwe

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Abstract

Despite the benefits associated with mining in Zimbabwe, gold, copper, chrome, palladium, platinum, and rhodium mining operations are linked to safety, health and environmental hazards that affect the host communities. Therefore, this research aims to assess the safety, health, and environmental management strategies implemented by Unki Platinum Mine to promote the safety and well-being of the host communities. A mixed-methods research approach that incorporated quantitative and qualitative methods was employed. Semi-structured questionnaires, key informant interviews, field observations, focus group discussions and secondary data sources provided research data. Quantitative data were analysed using the Statistical Package for the Social Sciences, and qualitative data were analysed using narrative analysis. Unki Platinum Mine has implemented safety, health, and environmental (SHE) management strategies compliant with national and international standards, including ISO 14001:2015, to safeguard host communities from mining hazards by promoting the principles of sustainable waste management. The mine provides access to clean water through borehole drilling and water quality testing, thereby protecting the community from waterborne diseases associated with the use of polluted water. Unki Platinum Mine provides emergency preparedness, community awareness, feedback mechanisms, and safety protocols to host communities in the event of a hazard. The mine has made significant investments and commitments to safety, health, and environmental sustainability through its social performance programs, which support host communities in thriving. The study developed a continual improvement framework to ensure that host communities derive positive benefits, perceptions, and experiences when interacting with mining operations.

Keywords

Platinum Mineral Group mining; Community health; Environmental hazards; Safety for mine host communities; Mining hazards

Introduction

The mining industry plays a crucial role in global economic growth (Kurakova and Ponomarenko, 2021; Hodge *et al.,* 2022; Sangaré, Sawadogo and Kabore, 2025). Despite its importance in economic growth and local development, mining operations expose the host communities to safety, health and environmental hazards. This suggests that the operational activities of mining industries are not fully aligned with Sustainable Development Goal 3, which aims to ensure healthy lives and promote well-being for all. Sonter *et al.* (2020) indicated that global demand for energy resources, precious metals and industrial minerals has increased, causing mining operations to expand into sparsely populated areas. According to Monteiro, da Silva and Neto (2019), the mining industry creates employment opportunities for local communities; however, negative effects arise from the mine's proximity to residential areas. The expansion of mining industries is associated with various challenges, including community displacement, noise pollution, land degradation, air pollution, and water pollution (Magidi and Hlungwani, 2023; Padhiary and Kumar, 2024). According to Sevelka (2023) and Sevelka (2025), the duration, scale and intensity of mining operations determine the magnitude of its effects on the surrounding communities. A study carried out by Mabey *et al*. (2020) in Sierra Leone reveals that communities located within the host communities of mines are exposed to noise, air, and water pollution. This means that safety, health, and environmental impacts related to mining operations extend beyond the mine workers, exposing nearby populations to chemicals and dust, as well as negatively altering their living conditions. According to Entwistle *et al.* (2019) and Leuenberger *et al.* (2021), communities near extraction industries are frequently affected by respiratory diseases due to dust inhalation and the use of water contaminated by tailings dams.

Although many African countries have experienced substantial increases in Gross Domestic Product and employment opportunities due to mining, host communities often suffer from safety, health, and environmental hazards (Chagadama and Vijjoen, 2024; Jeevanandam, 2025). This suggests that in Africa, the need to preserve ecosystems and the health of people in host communities often clashes with the mining industry's drive for economic growth. In African countries, these difficulties have been exacerbated by weak regulatory frameworks and limited institutional capabilities. According to Singo *et al.* (2022) and Ndiweni and Seif (2024), in developing countries such as Zimbabwe, the issue of small-scale mining and artisanal miners operating without adhering to regulations pose serious safety, health, and environmental hazards to local communities. The necessity of sustainable mining methods that prioritise community welfare and environmental protection has been acknowledged by national and international organisations; nevertheless, implementing and enforcing these standards continues to be challenging, especially in developing countries (Githiria and Onifade, 2020). This suggests that challenges related to mining operations are acute in developing countries. According to Leuenberger *et al.* (2021), particular social, economic and governance issues that many Sub-Saharan African nations face intensify the detrimental effects of mining. Communities that already face environmental vulnerabilities, poverty, and limited access to healthcare may be disproportionately affected by the negative impacts of mining.

Countries in Southern Africa, such as Zimbabwe, possess significant mineral resources, including platinum, gold, diamonds, coal, and lithium (Singo *et al.,* 2022; Mamuse von

der Heyden and Blenkinsop, 2024). However, the growth of the mining industry, particularly in Zimbabwe's platinum sector, has raised concerns about its safety, health, and environmental impacts, as well as its social footprint within nearby communities. For Zimbabwe, the Mines and Minerals Act Chapter 21:05 was the first mining law enacted. Additionally, several pieces of legislation, such as the Environmental Management Act (Chapter 20:27), were developed. Nonetheless, these legislations have drawn criticism from some civil society and non-governmental organisations for lacking adequate detail on how to protect host communities from safety, health and environmental hazards caused by mining operations. As a result, the ineffectiveness of the mining laws exposes local communities to various safety, health and environmental hazards. The mining sector is responsible for water pollution in nearby rivers due to the use of chemicals during its operations, which affects the quality of water consumed by local communities (Magidi and Hlungwani, 2023).

The vast mining industries in Zimbabwe have led to increased land degradation, improper waste management, water contamination, and poor air quality, as well as the relocation of communities. Despite this situation, limited studies have assessed the safety, health, and environmental (SHE) strategies implemented by the mining sector to safeguard host communities. Previous studies carried out by scholars such as Ncube-Phiri, Mucherera and Ncube. (2015), Ruppen *et al.* (2021), Magidi and Hlungwani (2023) and Ndiweni and Seif (2024) in Zimbabwe focus on the detrimental impacts of small and large-scale mining activities on host communities, for example, land degradation, health risks and water pollution, without indicating mitigation measures. These scholars have not provided a thorough evaluation of safety, health, and environmental measures, nor do they discuss how large-scale mines, such as the Unki Platinum Mine, practically implement these measures. Therefore, this study differs from previous works in that it moves beyond identifying problems by offering a comprehensive assessment of the safety, health, and environmental strategies used by Unki Platinum Mine to safeguard host communities and examines how these are implemented. Achievement of the Sustainable Development Goals (SDGs), specifically SDG 3 (Good Health and Well-being), SDG 6 (Clean Water and Sanitation), and SDG 11 (Sustainable Cities and Communities), requires a clear understanding of the SHE approaches. Therefore, the purpose of this study was to assess the perception of a multi-stratified sample of relevant actors regarding the effectiveness of safety, health, and environmental strategies implemented by Unki Platinum Mine to safeguard host communities from hazards associated with its activities. The objectives of the study were to identify measures used to manage safety, health, and environmental hazards faced by Unki Platinum Mine host communities, assess the effectiveness of existing safety, health, and environmental hazards, and develop a framework for continuously improving the effectiveness of safety, health, and environmental sustainability strategies.

Materials and Methods

Study Area

The study was conducted in the host communities of the Unki Platinum Mine. Unki Platinum Mine is situated in Shurugwi in the Midlands Province. The Unki Platinum Mine is situated on the Chironde Range on the Great Dyke. The platinum group of metals

are produced at the Unki Platinum Mine, including platinum, palladium, rhodium, gold, copper, and chrome. The Unki Platinum Mine is located near several water sources, including the Umtembekwe River. Zimbabwe's economy greatly benefits from the production of these metals at Unki Platinum Mine. Figure 1 shows the location of the Unki Platinum Mine.

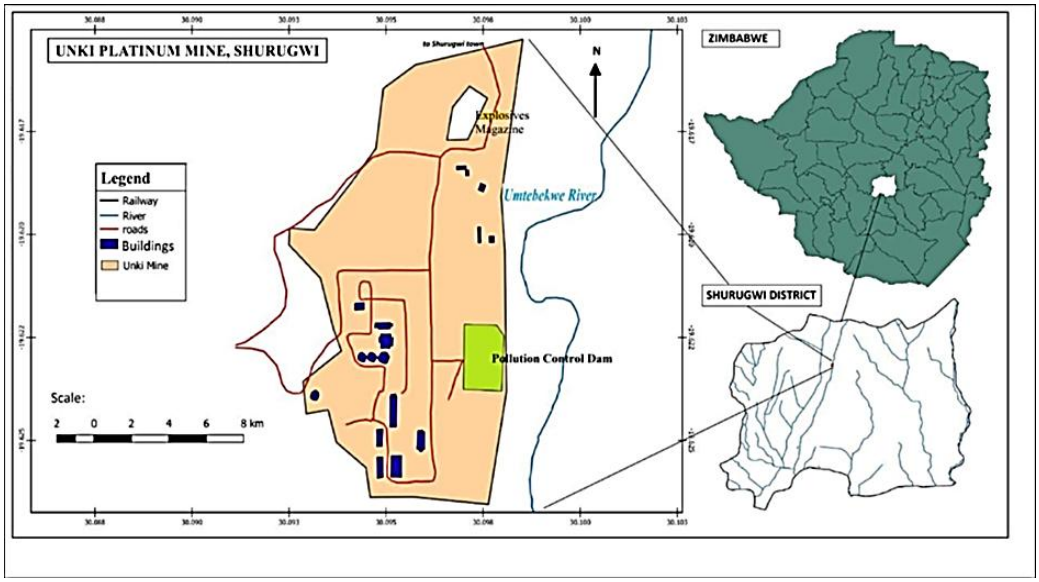

Figure 1: Location of Unki Platinum Mine [*Source:* Chihiya, Nhedzi and Mapira (2022)]

Study Design

The research design establishes and regulates the data collection procedures and data analysis strategies used throughout the study. A mixed-methods research design was employed in the study, as it integrates both quantitative and qualitative research approaches, known as triangulation, to meet the study's objectives.

Study Population

The study targeted residents who live within Unki Platinum Mine's host communities, for example, residents of Pasimupindu village, Gutsaruzhinji village, Peak Farm village and Village 6 in Shurugwi. Villagers were targeted as questionnaire respondents. The Rural District Administrator, Environmental Officer of Tongogara Rural District Council, Village Heads and Community Engagement Officer were targeted as interviewees. This was done to gather different views related to safety, health and environmental strategies implemented by Unki Platinum Mine to safeguard the host communities.

Sampling

Sample size for questionnaire respondents was calculated using Taro Yamane's 1967 formula. The study was conducted at a 95% confidence level and with a 0.05 (5%) margin of error. Taro Yamane's formula is:

$$n = \frac{N}{1 + N(e)2}$$

Where: n = Sample Size,
N = Total number of households in selected villages, and
e = margin of error (0.05 or 5%).

The total number of households from the selected villages was 210 (Pasimupindu), 200 (Gutsaruzhinji), 140 (Peak Farm), and 120 (Village 6), totaling 670 households. After calculations were done a sample size of 251 households was derived from 670 households. Stratified random sampling was used to select 251 households from 670 households, then simple random sampling was used to select households within each stratum. Purposive sampling was used to select interviewees.

Data Collection

Data was collected using primary and secondary data sources. Primary data were collected using questionnaires (Appendix 1), semi-structured interview guides (Appendices 2, 3, 4, and 5), an observation checklist (Appendix 6), and focus group discussions (Appendix 7). Pilot testing of the questionnaire was done using 10% of the study population. This means 25 households participated in the pre-test study. This was in line with Nyariki (2009), who recommended that pilot testing of the questionnaire should comprise 10% of the study population. Pilot testing was conducted to assess the applicability of the questions to the study, the clarity of the questions, and the time required to complete the questionnaire. The questionnaire was improved based on the feedback obtained during the pilot survey. This was done to ensure the questionnaire captured the required information. Experts in the field of safety, health and environment reviewed the questionnaires, interview guides, observation checklists and focus group discussion guides before they were distributed to the study participants. This was done to ensure the validity of the research instruments. The experts verify whether the research instruments align with the aspects of safety, health, and environmental strategies implemented by Unki Platinum Mine to protect host communities. Suggestions from the experts helped in rephrasing questions within the instruments. Primary data related to the safety, health, and environmental strategies implemented by Unki Platinum Mine to safeguard host communities were collected. Respondents were also asked to provide their suggestions for improving existing safety, health, and environmental practices used to protect the host communities of Unki Platinum Mine. Secondary data sources were used during the study. Secondary data were gathered through a review of journal articles, External Context Review reports, Community Engagement Forum Reports, Social Performance Reports and Unki Platinum Mine's Annual Report documents related to the topic, including reports, journal articles, and government regulatory documents. Secondary information collected during the study complements data collected using primary data sources.

Data Analysis

Quantitative data collected using closed-ended questions within the questionnaire were analysed using the Statistical Package for the Social Sciences (SPSS) version 25. A confidence interval of 95% and a significance level of 0.05 (5%) were used. Descriptive

statistics, for example, frequencies and percentages, were in the study. Output produced during quantitative data analysis was presented in the form of tables, bar charts, pie charts and frequency distribution as summary statistics. Non-numerical data collected through observations, focus group discussions, and interviews were analysed using narrative analysis. Narrative analysis was done to understand the meaning of the qualitative data. Narrative analysis has been a popular technique in the social sciences for qualitative data analysis (Khoa, Hung and Hejsalem-Brahmi, 2023). Narrative elements, such as recurring themes, were identified and explored to determine how the narratives relate to the study's objectives.

Results and Discussion

Demographic Characteristics

Figure 2 and table 1 depict the gender of respondents during the study. The majority (59%) of the respondents were females while males constituted 40.6% during the survey. In rural home settings, women typically take care of household duties while their partners are at work. In mining communities, men are often involved in mining activities, either formally or informally, which may limit their availability to participate in community surveys conducted during working hours, as similarly noted in Mengba, Atanga and Akurugu (2022).

Table 1: Gender of Respondents

Gender of Respondents	*Percentage of Respondents*
Females	59.38%
Males	40.62%

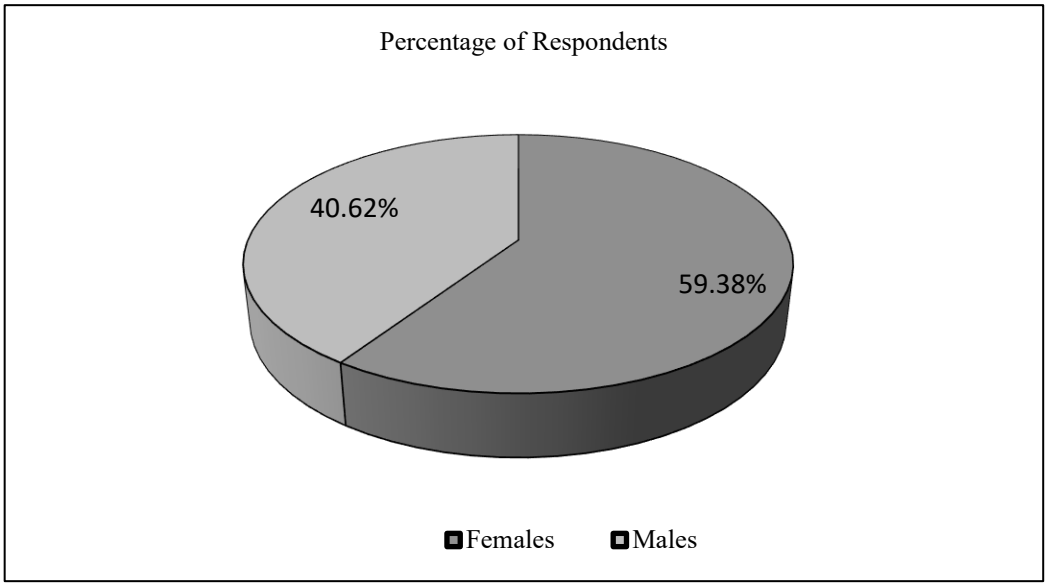

Figure 2: Gender of Respondents

Regarding the age of respondents, most (34.4%) were between 35 and 44 years old, as shown in table 2 and figure 3. This age group is frequently lured to mining regions by the prospect of better employment opportunities and financial prospects that are directly or indirectly related to mining activities. Although the mining industry poses risks, it offers higher compensation than other businesses, which attracts individuals seeking to improve their socio-economic status (Dikgwatlhe and Mulenga, 2023).

Table 2: Age of Respondents

Age of Respondents	*Percentage of Respondents*
18-24	12.5%
25-34	28.1%
34-44	34.3%
45-54	13.2%
55-64	10.1%
65^{+}	1.5%

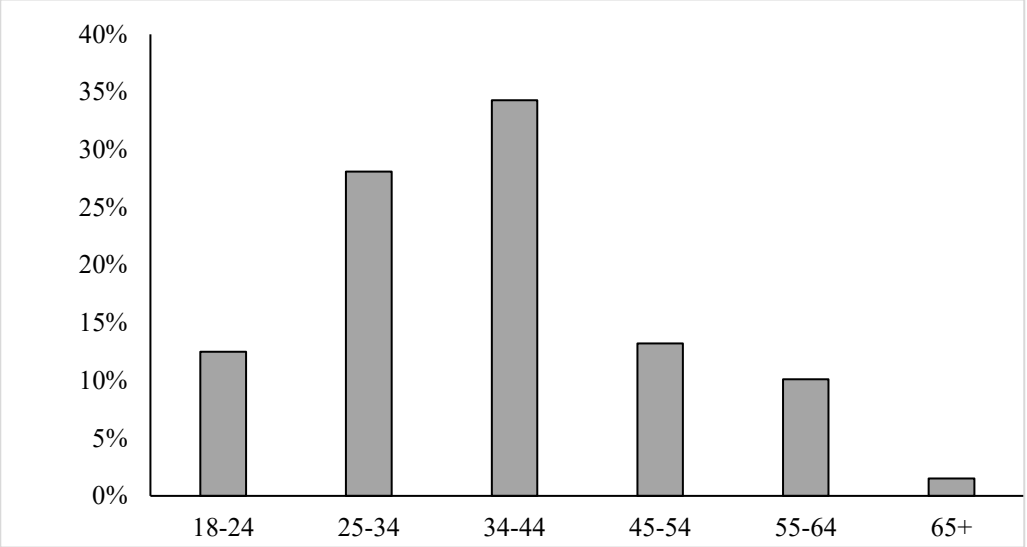

Figure 3: Age of Respondents

Strategies Implemented by Unki Platinum Mine to Safeguard Host Communities Provision of Clean Water Access through Borehole Drilling

During the interviews, the Rural District Administrator and the Village Heads expressed their views, indicating that Unki Platinum Mine drilled boreholes for host communities to access clean water. During observations, boreholes were observed in all educational institutions and health facilities near the active mining area. Through the installation of boreholes, the Unki Platinum Mine is enhancing the health of the people within its host communities. The strategic positioning of boreholes within health and educational facilities enhances their impact by ensuring that risk groups, including those seeking medical care and children, can access clean water. According to Jagaba *et al.* (2024), mining operations are a source of heavy metals, including chromium, copper, and mercury, which can cause water contamination. At the Unki Platinum Mine, heavy

metals are used in mineral processing, despite their potential to contaminate surface and groundwater sources, thereby increasing the potential for health problems. To mitigate the issues caused by heavy metals, Unki Platinum Mine treats its wastewater before disposal. This was supported by environmental quality results which illustrated that water from the mine's discharge point was clear at 0 km (Figure 4). This is attributed to their compliance with Zimbabwe's Environmental Management Agency standards. As a result, Unki Platinum Mine is working to help Zimbabwe meet the demands of the Sustainable Development Goals (SDGs), such as SDG 6 (Clean Water and Sanitation). According to Manyakaidze, Musavengane and Simatele. (2024), development projects in Zimbabwe that focus on providing water place a strong emphasis on borehole drilling to support the achievement of SDG 6. However, the majority (42.1%) of the study participants, as reported in table 3 and figure 5, indicated that water conservation should be practised. This indicates that participants are aware that continuous drilling of boreholes stresses underground water sources, which in turn may affect future generations. In Zimbabwe, the abstraction of groundwater by drilled boreholes has reached an alarming rate, depleting groundwater sources (Banhire, Muziri and Matamanda, 2019). The risk of aquifer depletion in Zimbabwe is high because the country receives low annual rainfall, which cannot replenish the aquifers sufficiently, yet the aquifers are the primary source of water for boreholes (Mambondiyani, 2020).

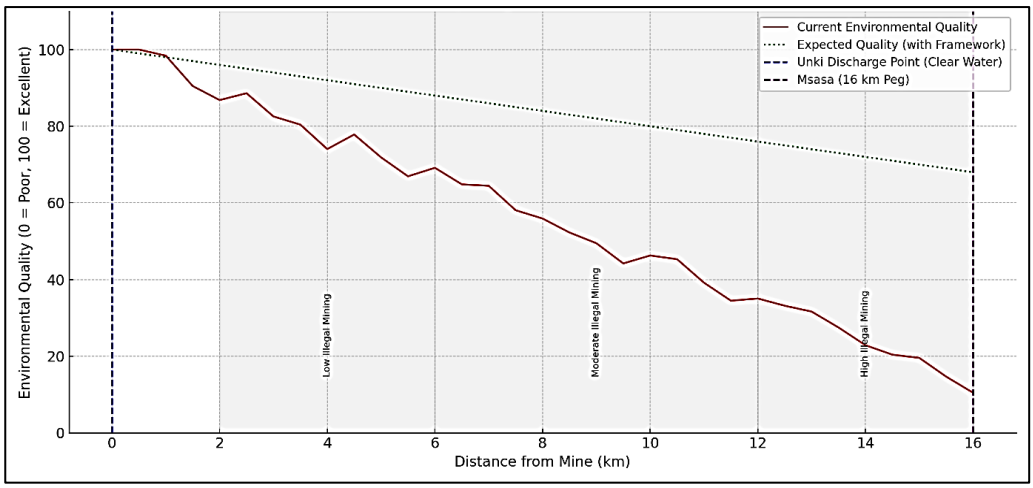

Figure 4: Environmental quality results

Water Testing and Capacity Building in Communities

During the study, the Community Engagement Officer reported that Unki Platinum Mine compliments borehole installation by testing the quality of the drinking water. Responses from the focus group discussions reveal that water testing and capacity-building initiatives are conducted by the mine. Water quality testing is vital in lowering health risks. The fact that the focus group discussion results align with those of the Community Engagement Officer suggests that water testing and capacity building are effective measures to protect the community. This means Unki Platinum Mine's initiatives align with global health initiatives that focus on safe water, sanitation, and hygiene (WASH), which is crucial for human health and well-being. Islam *et al.* (2021) stated that assessing water quality is an essential part of activities that support development, as it enhances

the health of people within the region. However, during the study, members of the focus group discussions reported that, while water quality testing is conducted, there is limited community access to test results. According to 18.7% of the questionnaire respondents, community engagement needs to be improved to facilitate the open disclosure of water quality reports to the community, as shown in table 3 and figure 5. This suggests that there may be a lack of transparency between the Unki Platinum Mine and the host community. As a result, a framework is needed to improve transparency between the mine and the host communities. This will enhance the effectiveness of safety, health and environmental sustainability within the host community.

Waste Management

The response from the Environmental Officer of Tongogara Rural District Council indicated that, to improve waste management in villages around the mine, Unki Platinum Mine set up bins using oil drums on local roads and in various locations. Unki Platinum Mine complies with Statutory Instrument 6 on solid waste and effluent disposal, a legal framework enforced by the Environmental Management Agency (EMA). This implies that the Unki Platinum Mine operates in accordance with reputable environmental laws, which is important in safeguarding public health and the environment. The mine also operates in accordance with international environmental management systems, such as ISO 14001. According to ISO 14001, mining companies are required to adhere to proper waste management practices. Additionally, Unki segregates its hazardous and regular waste in separate landfills. Doing this helps ensure the safe disposal of materials and reduces the risk of mixing them. According to Chihiya, Nhedzi and Mapira. (2022), among the fundamental principles of waste management, waste separation is crucial, particularly for mining industries that generate a wide range of waste. During observations, drums converted into bins were observed within communities in the vicinity of the mine. This reduced the number of drums thrown away since they were reused as bins. The initiative of installing bins in the community addresses waste disposal challenges, as disposal and collection points are readily accessible. Nevertheless, the effectiveness of the bins is affected by poor maintenance and misuse by residents, according to the Village heads. This means the impact of Unki Platinum Mine's initiatives has gone down due to the community's lack of ownership. Additionally, 39.2% of the study participants pointed to waste management as an area that needs continual monitoring within the mining environment (Table 3 and Figure 5). This indicates that waste management practices are in place at the Unki Platinum Mine; however, continuous monitoring is necessary to prevent future hazards and ensure the mine's compliance with environmental regulations at all times. Therefore, a framework that encourages participation of all stakeholders and continuous improvement to enhance the effectiveness of measures used to manage hazards in Unki Platinum Mine's host communities should be developed.

Table 3: Environmental Practices Needed

Environmental Practices Needed	*Percentage of Respondents*
Community Engagement	18.7%
Water Conservation	42.1%
Continuous Monitoring of Waste Management	39.2%

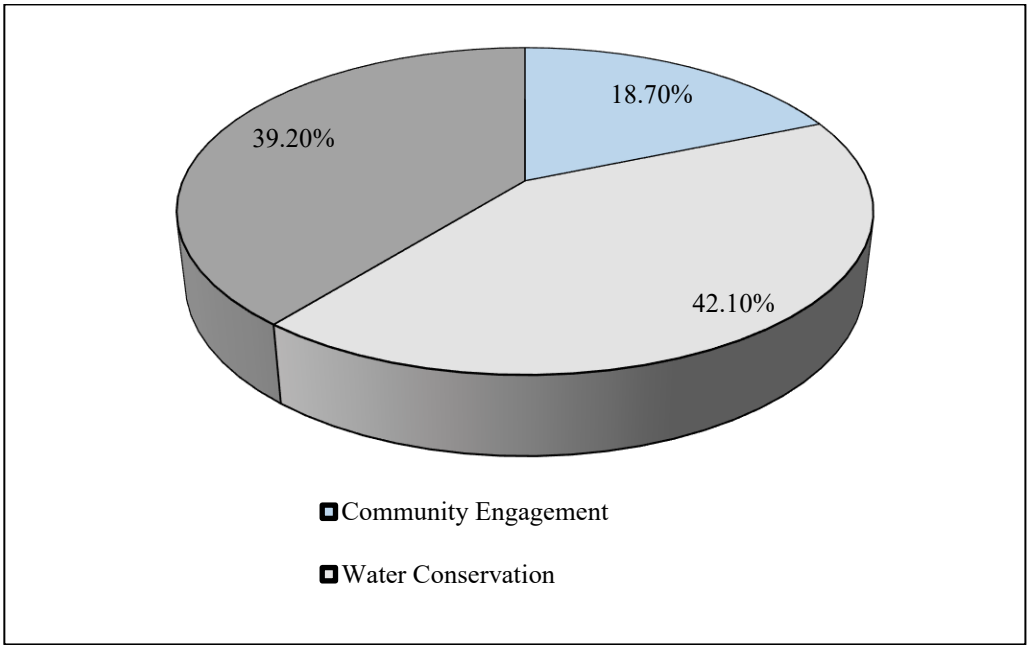

Figure 5: Environmental Practices Needed

Road Safety Enhancement

Most of the questionnaire respondents highlighted that with increasing road risks following new infrastructure. Unki Platinum Mine introduced measures to reduce traffic challenges. Road safety measures, such as road signs, speed bumps, and solar-powered streetlights were mentioned by respondents in the questionnaire. Members of the community indicated that road signs and solar-powered streetlights are installed along the major entrances of schools and community settlements to control speeding and enhance nighttime visibility. This demonstrates that Unki Platinum Mine has implemented road safety enhancements to reduce the risk of road collisions involving motorists, pedestrians, and cyclists. This links development and safety within Unki Platinum Mine's host communities. During the study, road signage, lights and guardrails used to manage accidents were observed. Findings reveal that Unki Platinum Mine uses various methods to protect the community from road accidents. The mining industry improves development within host communities; however, infrastructural development, such as roads, increases traffic volume in the area, thereby elevating the risk of accidents (Magidi and Hlungwani, 2023). Although road signs exist within the host communities, during observations, vandalised road signs were observed. Vandalism of road signs constructed by Unki Platinum Mine by community members indicates a lack of understanding among community members regarding their importance. Interviews also reveal that some of the community members ignore road signs. Therefore, any framework developed should include measures to enhance community awareness of the importance of road signs.

Slime dam drills, alert systems and communication tools for emergency preparedness

When asked about measures used to protect the community, the Community Engagement Officer reported that Unki Platinum Mine practised slime dam drills. Both

mine workers and community representatives participated in the drills. Evacuation routes and protocols are shared with community members through periodic training and visual guides. Results indicated that the Unki Platinum Mine trains both community members and mine workers on emergency preparedness and evacuation procedures, which are crucial in the event of hazards. Focus group discussions revealed that the Unki Platinum Mine distributed satellite phones to key community members and leaders, enabling them to communicate effectively during emergencies. This suggests that the Unki Platinum Mine addresses the issue of network disruptions that can occur during disasters due to network overload. Sirens installed at the Unki Platinum Mine alert residents efficiently, with each indicating a specific hazard. These preparedness strategies have improved community awareness, response times and coordination during potential safety, health and environmental emergencies. A holistic approach, including drills, alert systems, and communication tools, is crucial for mitigating the impacts of safety, health, and environmental hazards on the host communities of mines (Leuenberger *et al.,* 2021). However, during the study, focus group discussions revealed gaps in emergency preparedness measures, as participation was limited among a selected group of community members involved in the Community Engagement Forum. In Table 4 and figure 6, the majority (50%) of respondents indicated that they were not involved, suggesting the contribution of local people in emergency preparedness plans was lacking. Questionnaire respondents (30%) reported being somewhat involved, indicating that local people are participating in the implementation of emergency preparedness plans, but passively. These responses appear to follow a partial model, consistent with consultation or knowledge transfer, but not active participation in planning, monitoring, or evaluation. A minority (20%) of the study participants reported being very involved, indicating that a certain proportion of the local people made significant contributions during emergency preparedness plans. For the majority of the participants, the involvement of community members in drills is limited, which undermines the efficacy of emergency preparedness plans. This means there is a need for a framework that encourages the participation of all stakeholders to continuously improve safety, health, and environmental measures used to protect the host communities.

Table 4: Community Perception on Community Involvement

Community Perception on Community Involvement	*Frequency of Respondents*	*Percentage of Respondents*
Not Involved	126	50%
Somewhat Involved	75	30%
Very Involved	50	20%

Effectiveness of Strategies Implemented by Unki Platinum Mine to Safeguard Host Communities

Most (86%) of the questionnaire respondents reported that, since the drilling of boreholes by the Unki Platinum Mine, there has been an improvement in accessing clean water. One of the interviewees reported that cases of waterborne diseases were high before the mine drilled boreholes were installed for the community, but now there is a reduction in waterborne diseases. This indicates that initiatives introduced by Unki Platinum Mine, such as borehole drilling, improve public health outcomes. Drilling of boreholes is effective because it safeguards the well-being of mine host community members

(Mundjulu, 2025). Various responses from the interviewees indicated that the provision of bins around the community by Unki Platinum Mine reduces littering and improves the community's cleanliness. According to the results, even a simple method, such as using bins, can improve environmental cleanliness by reducing littering. More than half (64%) of the residents who participated as questionnaire respondents pointed out that the community was now safer since the implementation of road signs by Unki Platinum Mine. Findings indicated that the road users, both drivers and cyclists, are adhering to road signs, a situation which reduces the occurrence of accidents. Clear road signs increase awareness among drivers and improve traffic flow within communities, thereby reducing accidents (Babić *et al*., 2020). Some (36%) of the participants highlighted that, although road signs implemented by Unki Platinum Mine reduced accidents, some near-miss incidents continue to occur. Near-miss incidents do not cause harm, but they are vital in predicting future mishaps and identifying areas that need safety improvement. Therefore, strategies are needed to continuously improve the effectiveness of safety, health, and environmental sustainability (Menanno, Savino and Ciarapica, 2021; Jerie *et al.,* 2025).

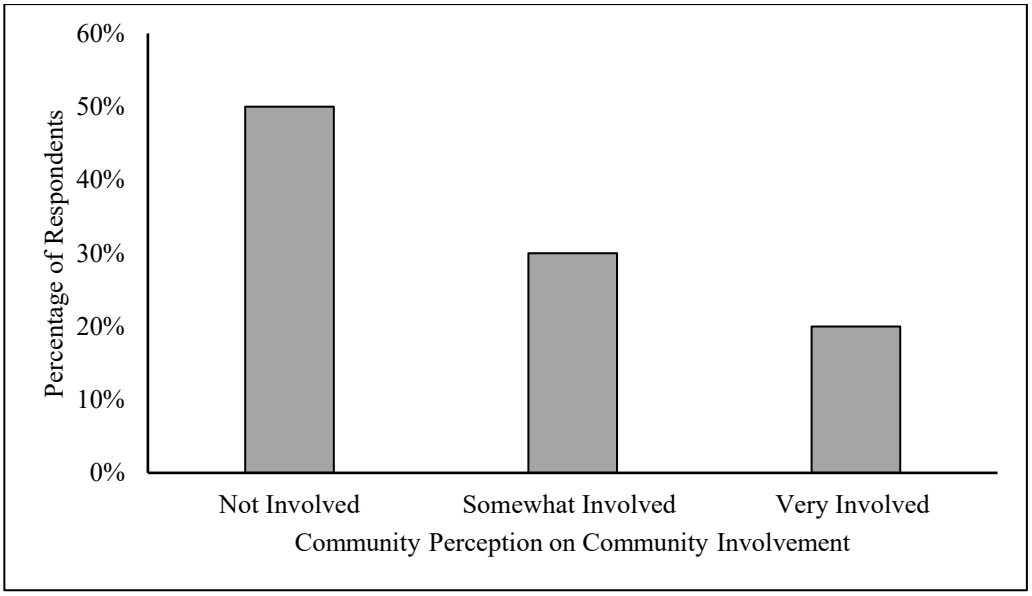

Figure 6: Community Perception on Community Involvement

Findings provided by the interviewees illustrated that they have confidence in emergency preparedness and response activities carried out by Unki Platinum Mine. This indicated that Unki Platinum Mine used a certain percentage of money from mining production to invest in programs that focus on empowering and educating host communities. Unki Platinum Mine is focusing on enhancing the safety of local people, which in turn improves the relationship between the mine and the host communities. In communities where mining activities pose safety, health, and environmental risks, effective awareness programs are crucial for promoting responsible mining practices (Awogbami *et al.,* 2024). Although responses indicate that the strategies employed by Unki Platinum Mine to safeguard host communities are effective, a framework is needed to continuously improve these strategies and promote scalability, as safety, health, and environmental challenges are context-specific and dynamic.

Proposed framework to enable continuous improvement of safety, health and environmental sustainability strategies

The framework was developed based on the Plan-Do-Check-Act (PDCA) cycle. to continuously improve the effectiveness of safety, health and environmental sustainability within Unki Platinum Mine's host communities. According to Pawandiwa *et al.* (2022), the Plan, Do, Check, and Act cycle, also known as the Deming Cycle, is a systematic approach designed to solve problems and facilitate continuous improvement. The proposed framework encompasses the planning stage, the implementation stage, the monitoring and evaluation stage, and the review and adaptation stage. Figure 7 illustrates the framework developed to continually enhance the effectiveness of safety, health, and environmental sustainability strategies.

The first stage of the proposed framework is planning and scoping. A baseline assessment should be conducted to understand the safety, health, and environmental sustainability strategies employed to protect the mine's host communities. Baseline assessment is significant in identifying areas that require improvement (Key *et al.,* 2023). At this stage of the proposed framework, hazard identification must be conducted. This is vital in identifying hazards affecting the mine's host communities, assessing the frequency of occurrence, and evaluating the severity of the consequences. Hence, the information can be used to understand community vulnerabilities. During the planning stage, all stakeholders should be engaged, including community members, traditional leaders, mine management, non-governmental organisations, members of the Environmental Management Agency and Rural District Council. All stakeholder involvement aims to improve awareness of all members. This means the framework will enhance the effectiveness of safety, health and environmental sustainability by addressing all stakeholders' priorities regarding the safety of the mine's host communities. This phase of the framework involves allocating resources and developing strategies in areas where a lack of necessary resources hinders the effectiveness of measures.

The framework presented in figure 7 includes the implementation stage. At this stage, the strategies developed during the planning stage should be implemented. This involves discouraging vandalism of road signs, providing safety training to members in the vicinity of the mine, and encouraging community members to participate in emergency drills. Capacity building on road safety and transport risk mitigation should involve vulnerable groups, such as school children. As a result, this framework encourages community members to follow road safety rules, which enhances the effectiveness of road signs in preventing accidents within the mine's host communities. The implementation stage of the framework promotes transparency in communication. This indicates that there should be open communication regarding safety, health and environmental sustainability strategies between the mine and its communities. Safety, health and environment (SHE) data, complaints and responses are to be made accessible to the public, for example, water quality testing results.

The third stage of the framework is monitoring, evaluation and learning. Performance monitoring should be conducted at this stage. This implies that the framework advocates for regular collection and analysis of information related to safety, health and environmental indicators. Information collected must be related to safety incidents, such

as near misses and injuries, as well as environmental parameters, including water quality and health statistics, including waterborne diseases. Measures implemented to manage hazards and enhance the effectiveness of already existing measures should be evaluated. Feedback about the effectiveness of the measures should be collected from both the mine management and community members. This means the mine must establish suggestion boxes for community members. The last stage of the developed framework is the strategy adjustment stage. In this stage, data from monitoring and evaluation is analysed to identify areas where measures are not effective. Conclusions obtained in this stage inform the planning stage, creating another cycle for improvement. This suggests that the developed framework is dynamic to emerging mine hazards, which can affect the host communities. Therefore, Unki Platinum mine can apply proactive measures to enhance safety, health, and environmental sustainability within host communities, rather than relying solely on reactive measures. The developed framework for continuous improvement provides an adaptable approach that ensures safety, health, and environmental sustainability measures evolve and remain effective.

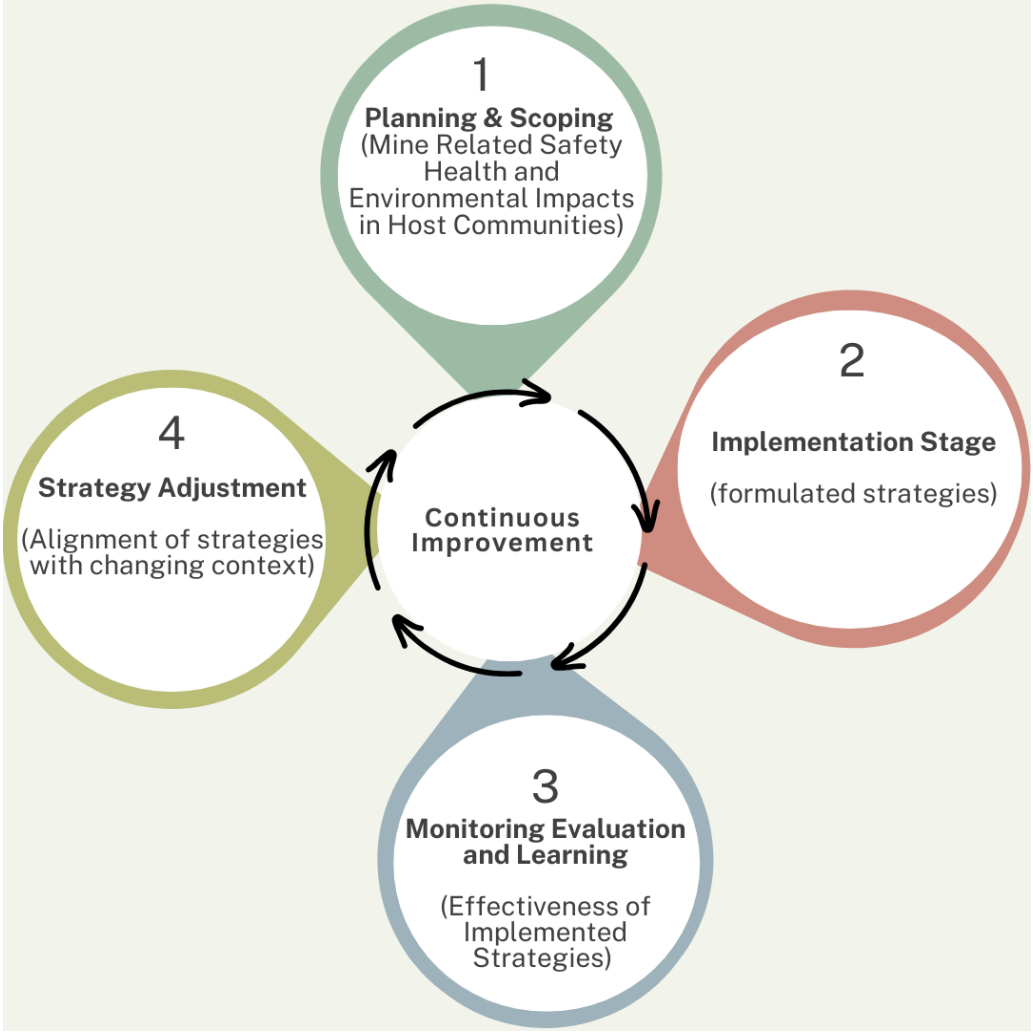

Figure 7: A Continuous Improvement Framework for Safety, Health and Environmental Sustainability Strategies

Conclusion and Recommendations

Unki Platinum Mine serves as a major contributor to economic growth and infrastructure development in its host communities. The mine strives to safeguard communities within its vicinity from safety, health, and environmental hazards associated with mining activities, including water pollution, dust pollution, emissions from the smelting process, and solid waste. Unki Platinum Mine prioritises the well-being of host communities by providing access to clean water through borehole drilling and water testing. Residents within Unki Platinum Mine's host communities are protected from waterborne diseases such as cholera and dysentery, as the mine invests in water treatment and infrastructure. Unki Platinum Mine complies with Statutory Instrument 6 on solid waste and effluent disposal, a legal framework enforced by the Environmental Management Agency. This highlights that Unki Platinum Mine adheres to national frameworks when conducting its operations to ensure environmental sustainability. Capacity-building initiatives carried out by Unki Platinum Mine in host communities have increased the knowledge of local people regarding emergency preparedness and road safety. This indicates that the mine is dedicated to promoting the well-being of the host community residents. Furthermore, the mine employs waste management strategies, such as landfills, to ensure that its activities do not negatively impact the ecosystem and the well-being of people who rely on natural resources. Although the Unki Platinum Mine implements measures to protect host communities from hazards, these measures need to be continually improved to address emerging risks effectively. To achieve this, a framework was developed. The proposed framework encompasses the planning stage, the implementation stage, the monitoring and evaluation stage, and the review and adaptation stage. The developed framework for continuous improvement provides an adaptable approach that ensures safety, health, and environmental sustainability measures evolve and remain effective. To enhance the adoption of the developed framework, the study recommends integrating various stakeholders, including members of the Environmental Management Agency, Rural District Council, traditional leaders, community members, non-governmental organisations, and mine management members. This is important for knowledge transfer.

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Appendices

Appendix 1

Questionnaire

Topic: Safety, Health and Environmental Management Strategies Implemented to Safeguard Unki Platinum Mine's Host Communities in Shurugwi District, Zimbabwe
Your participation in this research requires your completion of the following survey questions. We guarantee the privacy of your responses and will dedicate your contribution to academic research.

Please tick where applicable

Section A: Demographic Information

A_1 Household Code…….

A_2 Age

- 1 18- 24
- 2 25 – 34
- 3 35 – 44
- 4 45 – 54
- 5 55 – 64
- 6 65 or over

A_3 Gender:

- 1 Male
- 2 Female
- 3 Prefer not to say

A_3 Education Level:

- 1 Never attended Primary
- 2 Primary
- 3 Secondary
- 4 Tertiary
- 5 Informal

A_4 Occupation: …….
A_5 Household Size

- 1 less than 3
- 2 4 – 6
- 3 7 – 10
- 4 11 and over

Section B: Mining Awareness and Perception

B_1 Are you aware of the mining operations at Unki Platinum Mine?

- 1 Yes
- 2 No

B_2 How do you perceive the impact of mining on your community?

- 1 Positive
- 2 Negative
- 3 No impact

B_3 What specific concerns do you have regarding mining activities?

- 1 Air pollution
- 2 Water contamination
- 3 Land degradation
- 4 Health Risks
- 5 Employment opportunities
- 6 Other (Specify) ……..

Section C: Safety Concerns

C_1 Have you or anyone in your household experienced health issues related to mining activities?

- 1 Yes
- 2 No

C_2 How would you rate the safety measures implemented by Unki Platinum Mine?

- 1 Very effective
- 2 Effective
- 3 Neutral
- 4 Ineffective
- 5 Very ineffective

C_3 What safety measures do you think should be prioritized?

- 1 Regular health check-ups
- 2 Community training programs
- 3 Emergency response plans
- 4 Environmental monitoring
- 5 Other (Specify) ……...

Section D: Environmental Sustainability

D_1, Do you believe that Unki Platinum Mine is taking adequate steps to protect the environment?

- 1 Yes
- 2 No

D_2 What environmental practices do you think are most important for mining companies?

- 1 Waste management
- 2 Water conservation
- 3 Reforestation
- 4 Community engagement

D_3 Are you aware of any initiatives by Unki Platinum Mine aimed at enhancing environmental sustainability?

- 1 Yes

- 2 No

Section E: Community Involvement and Recommendations

E_1 How involved do you feel your community is in discussions about mining practices?

- 1 Very involved
- 2 Somewhat involved
- 3 Not involved

E_2 What strategies do you recommend for improving safety and environmental sustainability in your community?

……

E_3 Would you be willing to participate in community meetings regarding mining activities?

- 1 Yes
- 2 No

Section F: Additional Comments

F_1 Please provide any additional comments or suggestions regarding mining operations and their impact on your community:

……
……
……
……
……
……

Appendix 2

Interview Guide

Environmental Officer of Tongogara Rural District Council

Topic: Safety, Health and Environmental Management Strategies Implemented to Safeguard Unki Platinum Mine's Host Communities in Shurugwi District, Zimbabwe

1. What safety, health and environmental concerns do community members raise most frequently about Unki Platinum Mine?
2. What safety, health and environmental changes has the community observed due to mining?
3. Are you aware of any safety, health and environmental initiatives by Unki Platinum Mine? If so, how effective are they?
4. How would you rate the mine's responsiveness to these safety, health and environmental concerns?
5. What barriers prevent the community from participating in mining related safety, health and environmental discussions?
6. Are there examples from other mining communities that Unki could learn from?
7. How could Unki Platinum Mine improve trust and collaboration with the community on these issues?
8. What specific actions should the mine prioritize to enhance community safety and health and environmental protection for the community?
9. How should the community be involved in monitoring mining impacts over time?
10. What future changes would you like to see in Unki Platinum Mine's approach to community safety, health and sustainability?

Appendix 3

Interview Guide

Unki Platinum Mine Official-Community Engagement Officer

Topic: Safety, Health and Environmental Management Strategies Implemented to Safeguard Unki Platinum Mine's Host Communities in Shurugwi District, Zimbabwe

1. What environmental hazards pose the greatest threat to the community?
2. What are the most significant safety, health and environmental risks to the host communities from Unki Platinum Mine's operations?
3. Which environmental management practices at Unki Platinum Mine have been most successful, and why?
4. How effective are the current protocols/measures in mitigating these risks?
5. How does Unki Platinum Mine monitor and evaluate the effectiveness of its safety and environmental strategies for host communities?
6. Are there any best practices from other mines that could improve safety, health and environmental sustainability for your host communities?
7. What gaps exist in current mitigation frameworks
8. How can community feedback be better integrated into their safety and environmental decision-making?
9. What additional safety, health and environmental measures would you recommend to better protect the community?
10. What long-term strategies would you propose to ensure continuous improvement in safety and sustainability for your host communities?

Appendix 4

Interview Guide

Rural District Administrator

Topic: Safety, Health and Environmental Management Strategies Implemented to Safeguard Unki Platinum Mine's Host Communities in Shurugwi District, Zimbabwe

1. How would you describe the current relationship between Unki Platinum Mine and surrounding host communities regarding their safety, health and environmental matters?
2. What are the most common safety, health and environmental concerns raised by communities about Unki Platinum Mine's operations?
3. How effective are the existing coordination mechanisms between the Rura District Council, Unki Platinum Mine and communities in addressing these concerns?
4. What specific environmental protection measures have you observed being implemented by Unki Platinum Mine?
5. What safety protocols has the mine established that directly impact host communities?
6. How does the Rural District Council currently monitor and evaluate Unki Platinum Mine's compliance with safety, health and environmental regulations?
7. What successful practices from other mining districts could be adapted to improve safety, health and sustainability here?
8. What additional measures would you recommend to strengthen community involvement in safety and environmental monitoring?
9. How could the existing regulatory framework be improved to better protect host communities?
10. What specific actionable steps should Unki Platinum Mine prioritize to enhance safety and health standards and environmental sustainability?

Appendix 5

Interview Guide

Village Head

Topic: Safety, Health and Environmental Management Strategies Implemented to Safeguard Unki Platinum Mine's Host Communities in Shurugwi District, Zimbabwe

1. How would you describe the relationship between Unki Platinum Mine and its host communities?
2. What are the most common safety, health and environmental concerns raised by communities about Unki Platinum Mine's operations?
3. What measures has Unki Platinum Mine introduce to protect host communities from safety, health and environmental hazards associated with its operations?
4. What ways are used by Unki Platinum Mine to communicate issues related to safety, health and environmental hazards to the community?
5. How effective are the current protocols/measures in mitigating these risks
6. How does Unki Platinum Mine monitor and evaluate the effectiveness of its safety and environmental strategies for host communities?
7. Are there any best practices from other mines that could improve safety, health and environmental sustainability for your host communities?
8. How can community feedback be better integrated into their safety and environmental decision-making?
9. What additional safety, health and environmental measures would you recommend to better protect the community?
10. What long-term strategies would you propose to ensure continuous improvement in safety and sustainability for your host communities?

Appendix 6

Observation Checklist

Topic: Safety, Health and Environmental Management Strategies Implemented to Safeguard Unki Platinum Mine's Host Communities in Shurugwi District, Zimbabwe

Date of Observation: _____
Location: _____

Objective: Identification of existing safety, health and environmental sustainability standards
Estimate the distance between residential areas and mining activity zones.
Are there safety buffer zones?
Any indication of risk mitigation (e.g., retaining walls, controlled access)?

Objective: Effectiveness of health-related environmental management protocols
Are there signs of dust, noise, or water pollution near residences?
Evidence of waste mismanagement (open dumping, burning)?
Odors or visible emissions from mining processes?
Are clinics or health centres accessible and well-maintained?
Visible health campaigns, posters or public information on mining risks?

Objective: Evaluation of environmental management practices and identification of risks
Evidence of deforestation, land degradation, or water source contamination?
Are there reforestation or land reclamation projects?
Are community water sources protected or treated?
Are locals engaged in sustainability projects (recycling, cleanups)?
Any other environmental programs?

Objective: Comparison with best practices and proposing a framework
Any practices resembling international sustainability standards?
Any unique local solutions being implemented?
Are there feedback systems for reporting safety, health or environmental sustainability concerns?
Are information boards or community forums visible and functional?

Appendix 7

Focus Group Discussion Guide

Topic: Safety, Health and Environmental Management Strategies Implemented to Safeguard Unki Platinum Mine's Host Communities in Shurugwi District, Zimbabwe

1. How do you describe the relationship between Unki Platinum Mine and its host communities?
2. What are the safety risks that your community experience as a result of Unki Platinum Mine's activities?
3. Do you and your community members experience health problems due to Unki Platinum Mine's operations?
4. Is there any environmental problems you observed in your community that are associated with the mine's activities?
5. What measures are used by Unki Platinum Mine to protect the community from safety, health and environmental hazards associated with its operations?
6. How effective are the measures in protecting the community?
7. Which methods are used by Unki Platinum Mine to communicate safety, health and environmental hazards to the community?
8. What additional approaches do you think can be implemented to improve measures used to protect the community from safety, health and environmental hazards by Unki Platinum Mine?

Authors' Declarations and Essential Ethical Compliances

Authors' Contributions (in accordance with ICMJE criteria for authorship)

Contribution	*Author 1*	*Author 2*	*Author 3*	*Author 4*	*Author 5*
Conceived and designed the research or analysis	Yes	Yes	Yes	Yes	Yes
Collected the data	No	Yes	No	No	No
Contributed to data analysis & interpretation	Yes	Yes	Yes	Yes	Yes
Wrote the article/paper	Yes	Yes	No	No	No
Critical revision of the article/paper	Yes	Yes	Yes	Yes	Yes
Editing of the article/paper	No	Yes	No	No	No
Supervision	Yes	No	Yes	Yes	Yes
Project Administration	No	Yes	No	No	No
Funding Acquisition	Yes	No	Yes	Yes	Yes
Overall Contribution Proportion (%)	20	20	20	20	20

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Research involving human bodies or organs or tissues (Helsinki Declaration)
The author(s) solemnly declare(s) that this research has not involved any human subject (body or organs) for experimentation. It was not clinical research. The contexts of human population/participation were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of Helsinki Declaration does not apply in cases of this study or written work.

Research involving animals (ARRIVE Checklist)
The author(s) solemnly declare(s) that this research has not involved any animal subject (body or organs) for experimentation. The research was not based on laboratory experiment involving any kind animal. The contexts of animals were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of ARRIVE does not apply in cases of this study or written work.

Research on Indigenous Peoples and/or Traditional Knowledge
The author(s) solemnly declare(s) that this research has not involved Indigenous Peoples as participants or respondents. The contexts of Indigenous Peoples or Indigenous Knowledge were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or prior informed consent (PIC) of the respondents or Self-Declaration in this regard does not apply in cases of this study or written work.

Research involving Plants
The author(s) solemnly declare(s) that this research has not involved the plants for experiment and field studies. Some contexts of plants are also indirectly covered through literature review. Thus, during this research the author(s) obeyed the principles of the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora.

Research Involving Local Community Participants (Non-Indigenous) or Children
The author(s) solemnly declare(s) that this research has directly involved local community participants or respondents belonging to non-Indigenous peoples. This study has not involved any child in any form directly. The contexts of different humans, people, populations, men/women/children and ethnic people were only indirectly covered through literature review. Therefore, a prior informed consent (PIC) of the respondents or Self-Declaration in this regard applies in cases of this study or written work.

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)
The author(s) has/have NOT complied with PRISMA standards to an extent.

Competing Interests/Conflict of Interest
Author(s) has/have no competing financial, professional, or personal interests from other parties or in publishing this manuscript. There is no conflict of interest with the publisher or the editorial team or the reviewers.

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To see original copy of these declarations signed by Corresponding/First Author (on behalf of other co-authors too), please download associated zip folder [Declarations] from the published Abstract page accessible through and linked with the DOI: https://doi.org/10.33002/nr2581.6853.080308.

INFORMATION AND CONSENT FORM FROM RESPONDENTS
(Non-Indigenous Respondents)
This form was translated into local language for the respondents

Title of the Research: Safety, Health and Environmental Management Strategies Implemented to Safeguard Unki Platinum Mine's Host Communities in Shurugwi District, Zimbabwe

Principal Researcher:	**Pascal Manyakaidze**
	Takunda Davies Mupakamiso
Research Supervisor:	**Steven Jerie**
Other Researchers	**Tapiwa Shabani**
Who Participated	**Takunda Shabani**

A) INFORMATION TO PARTICIPANTS

1. Objectives of the research

The objectives of this study were to identify measures used to manage safety, health, and environmental hazards faced by Unki Platinum Mine host communities, assess the effectiveness of existing safety, health, and environmental hazards, and develop a framework for continuously improving the effectiveness of safety, health, and environmental sustainability strategies.

2. Participation in research

The researcher will ask you several pertinent questions. This interview will be recorded in written form and should last about 50-60 minutes. The location and timing of the interview will be determined by you, depending on your availability and convenience.

3. Risks and disadvantages

There is no particular risk involved in this project. You may, however, refuse to answer any question at any time or even terminate the interview.

4. Advantanges and benefits

You will receive intangible benefits even if you refuse to answer some questions or decide to terminate the interview. You will also contribute to a better understanding of the effectiveness of safety, health, and environmental strategies implemented by Unki Platinum Mine to safeguard host communities from hazards associated with its activities.

5. Confidentiality

Personal information you give us will be kept confidential. No information identifying you in any way will be published. In addition, each participant in the research will be assigned a code and only the researcher will know your identity.

6. Right of withdrawal

Your participation in this project is entirely voluntary and you can at any time withdraw from the research on simple verbal notice and without having to justify your decision, without consequence to you. If you decide to opt out of the research, please contact the researcher at the telephone number or email listed below. At your

request, all information concerning you can also be destroyed. However, after the outbreak of the publishing process, it is impossible to destroy the analyses and results on the data collected.

B) CONSENT

Declaration of the participant

- ⇨ I understand that I can take some time to think before agreeing or not to participate in the research.
- ⇨ I can ask the research team questions and ask for satisfactory answers.
- ⇨ I understand that by participating in this research project, I do not relinquish any of my rights, including my right to terminate the interview at any time.
- ⇨ I have read this information and consent form and agree to participate in the research project.
- ⇨ I agree that the interviews be recorded in written form by the researcher: Yes ( ) No ( )

Signature of the participant : _____ Date : _____

Surname : _____ First name : _____

Researcher engagement

I explained to the participant the conditions for participation in the research project. I answered to the best of my knowledge the questions asked and I made sure of the participant's understanding. I, along with the research team, agree to abide by what was agreed to in this information and consent form.

Signature of the researcher : Date : 12/29/2023

Surname: Shabani First name: Tapiwa

- ⇨ Should you have any questions regarding this study, or to withdraw from the research, please contact Mr. Tapiwa Shabani by e-mail research.office@lidagency.org

- ⇨ If you have any concerns about your rights or about the responsibilities of researchers concerning your participation in this project, you can contact the Centre for Information Learning and Knowledge Transfer Department, Local Initiatives and Development (LID) Agency, Stand 41 Donga Rural Service Centre, Shurugwi, Zimbabwe by e-mail research.office@lidagency.org